Heavy Bombers in the Close Air Support Mission: Has Their Time Come Again?

A Monograph
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This monograph discusses the question of whether or not the USAF should consider using heavy bombers in the Close Air Support (CAS) mission. To answer this question, the monograph develops a bomber CAS concept of operations. The validity of this concept has particular relevance in light of the on-going downsizing of the Department of Defense and the acceptance of a "Win-Near Simultaneous Win" national military strategy.

This paper presents current day CAS doctrine at both the tactical and theater level. Following this, a brief review of the British World War II CAS experiences in North Africa provides a historical perspective. From the doctrine and history, four evaluation criteria are selected which are used to analyze the proposed bomber CAS concept of operations.

The monograph concludes that USAF planners should consider bomber CAS as a potential combat multiplier. Successful implementation of this concept depends on two key areas, the development of precision standoff weapons and their subsequent employment on the bombers. The study further concludes that battlefield control is the greatest impediment to successful implementation. Planners must, therefore, emphasize the effective integration of bomber CAS assets into a theater air support system, both doctrinally and procedurally.

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I. Introduction

Aircraft have flown Close Air Support (CAS) missions in support of ground forces since shortly after man's first powered flight, starting with World War I. The US Air Force (USAF), in Air Force Manual 1-1 Basic Aerospace Doctrine of the United States Air Force, defines CAS as "the application of aerospace forces in support of the land component commander's objectives."[1] Further refinement is provided by the statement that CAS provides "...direct support to friendly forces in contact."[2] The Army, on the other hand, defines CAS missions as those which "...support land operations by attacking hostile targets close to friendly ground forces."[3] Although not exact in words, the bottom line, in both definitions, is that CAS supports the appropriate ground commander in achieving his battlefield objectives.

Achieving these battlefield objectives today is much more difficult for two reasons, a changing national military strategy and a decreasing defense budget. In two June 1993 speeches, Secretary of Defense, Les Aspin, outlined a new national security strategy commonly referred to as "Win-Hold-Win."[4] This strategy envisions the United States' Armed Forces having the capability to participate in and win two Major Regional Conflicts (MRC), similar in size and

intensity to the Gulf War, on a near simultaneous basis. In addition, the Secretary discussed the on-going Department of Defense (DOD) review of military roles, missions, and capabilities entitled "Bottom-Up Review."[5] Concurrent with these speeches and the on-going DOD effort was the release of a RAND Corporation study, commissioned by the US Air Force, on the changing use of airpower in the future.

This study, entitled "The New Calculus: Analyzing Airpower's Changing role in Joint Theater Campaigns," released 22 Jun 1993, was an evaluation of the US Armed Forces' ability fight, and win, two MRCs with one MRC taking place in Southwest Asia (SWA) and the second in North Korea (NK).[6] Primarily focusing on airpower, this study highlighted concerns raised by the planned downsizing of the US military and the resultant impact on dealing with near simultaneous MRCs. In fact, the RAND study states that with D-Days of the MRCs separated by less than three weeks, the US would be unable to deploy adequate forces to the second MRC in a timely fashion.[7]

No less significantly, force requirements for the first MRC would include a large portion of the available air forces: ten Air Force fighter wing equivalents (FWE), eighty bombers, and associated support aircraft.[8] These USAF requirements were derived from the "Base Force," developed by the

Chairman of the Joint Chiefs of Staff, General Colin Powell, which recommended USAF force levels of 26 FWE, and 184 bombers.[9] On the other hand, the "Bottom-Up Review, using the same MRC scenarios resulted in suggested USAF end strength of 20 FWE and 184 bombers.[10]

A quick comparison of the studies' recommendations shows a significant decrease in the recommended USAF force structure. The budget pressures of today are reflected in this decrease. For example, the fighter wing equivalents supported by the "Bottom-Up Review" will be 23 percent lower than those suggested by the RAND Study. The RAND study noted that the Air Force deployed 10 FWE to Iraq, which is 50 percent of available FWE available under the "Bottom-Up Review."[11] This in no way accounts for any aircraft which are used in training or undergoing depot maintenance. Consequently, the necessary aircraft required to achieve Secretary of Defense Aspin's goal of stopping the initial enemy armor attacks by air in the second MRC may not be available unless the USAF takes a more imaginative view of its combat aircraft's missions.[12]

As a specific example, the Air Force may want to consider the implications of once again using the heavy bomber (hereafter referred to as bombers) in the CAS mission. This may potentially provide necessary firepower in the second MRC when the majority of CAS

capable aircraft, the fighter aircraft, are already deployed to the first MRC.

CAS is probably the most intimate link between the US Army and Air Force; and yet, it is also one of the most controversial. Who will control it, how much firepower, how it is scheduled, and when it will arrive are historical questions of contention between the services. However, in the ever changing national security environment and decreasing defense budgets, CAS takes on an ever increasing importance as a combat multiplier. But, the CAS mission, as flown by the Air Force, has typically been flown by a fighter-type aircraft, although bombers have seen action as CAS aircraft in past wars. As the defense budget decreases and the US forces abroad are brought back to the Continental United States (CONUS), the Air Force may need to revise its concept of operations for the CAS mission and develop a way to integrate the heavy bomber into CAS planning.

This monograph attempts to answer the question of whether or not the USAF bombers can function in a CAS mission by proposing and evaluating a tactical concept of operations for this mission. The central focus is to look at the bomber as a stop-gap measure in the second MRC, delaying and, if possible, defeating the initial armor attacks. The intent of this concept is not to supplant the fighter aircraft in the CAS

mission, but, instead, provide the initial armor stopping power in the second MRC. In effect, this tactical concept will attempt to fulfill the airpower objectives outlined by Secretary of Defense, Les Aspin, in his June 1993 speeches and the "Bottom-Up Review."

This monograph begins by looking at the theory and history of CAS, emphasizing the tactical and theater level organization which function as the foundation for the concept of operation. As part of this foundation, several criteria, selected from the doctrinal and historical review, provide a means for evaluating the concept of operations. Following this, the monograph discusses future acquisition projects, such as planned bomber modernization and new weapons, which serve as the key building blocks for a bomber CAS concept of operations. The concept of operations is presented incorporating the both the concept and an analysis based on the selected criteria.

Finally, this paper provides conclusions as to the merit of the concept and answers the research question.

II. FOUNDATION

Before considering how bombers may play an increased CAS role, an understanding of the significance of the present USAF/USA CAS doctrine is important. First, one must understand the USAF view of

doctrine. In the foreword to AFM 1-1, General Merrill A. McPeak, USAF Chief of Staff, said

> Doctrine is important because it provides the framework for understanding how to apply military power. It is what history has taught us works in war, as well as what does not.[13]

His statement is very relevant since the USAF does not have the lengthy history of the other services to use in shaping doctrine. Accordingly, a well thought out doctrine takes on particular importance. The following paragraphs first outline the current USAF CAS doctrine, discussing the broad requirements for tactical implementation and then the USAF/USA theater air control system. Next, the monograph presents a brief discussion of the US Army's fire support organization which parallels the USAF's theater air control system and supports the CAS mission. A brief historical perspective based on British WW II CAS experience in North Africa follows this doctrinal exposure and shows the historical precedent for our present air support control system. Most importantly, General McPeak's statement reminds us that we must learn from history. The USAF CAS doctrine of today reflects this learning process.

The final portion of Section II describes several evaluation criteria derived from the doctrine and history of CAS. They provide the means of judging the validity of the bomber CAS concept of

operations developed in Section IV of this monograph.

Tactical CAS Doctrine

Two types of CAS requests, as prescribed in USAF manuals, exist today. They are preplanned and immediate CAS.[14] Preplanned CAS requirements are those planned far enough in advance to be included in the Air Tasking Order (ATO). Immediate CAS requests are those that arise from the dynamic situation on the battlefield and strike unanticipated or fleeing targets.[15] Both of these have one important common factor, the USAF's ATO. The ATO is, in function, similar to a USA's synchronization matrix as it integrates various weapon systems based upon available assets, mission timing, and mission specific requirements such as time on target (TOT), force package composition, or required munitions.[16] Consequently, aircraft fulfilling both the preplanned and the immediate CAS requests are scheduled in the ATO.[17]

Preplanned requests are further subdivided into scheduled or on-call air requests. Scheduled requests are those listed in the ATO with a specific target, TOT, and final control. On-call requests, on the other hand, are assigned to block times during which the requesting unit expects an enemy engagement to occur. The on-call mission, placed on alert status, is thereby prepared to launch when directed by the appropriate

authority.[18]

Since planning cannot cover all possible contingencies, the immediate request provides the means of obtaining additional firepower when needed. Although previously scheduled in the ATO, the aircraft used to fulfill this request are not dedicated to immediate requests. Instead, on-call sorties are normally diverted to fill this need, and, in an emergency, the preplanned sorties from lower priority missions can also be diverted to meet this requirement.[19]

The request process for CAS support is different for the two types of CAS. The fire support coordination elements of each echelon develop the preplanned requests and pass them to the next higher level for approval using the requesting service's organic communication nets. The receiving echelon then evaluates these requests and, if approved, forwards them to the next higher level. This continues until reaching the highest maneuver element of the force, for example a Corps and its collocated Air Support Operations Center (ASOC), where the request is approved and prioritized. The Land Component Commander (LCC) approves and prioritizes the requests and passes them the Air Operations Center (AOC), located with the theater commander, for execution.[20]

Immediate requests follow a different path, although they eventually end up at the ASOC. The

requesting unit, using the Air Force Air Request Net (AFARN), calls directly to the ASOC with the request. The intervening higher echelon units acknowledge the request; however, silence on the communication net, after the acknowledgement, signifies request approval. The AOC then executes the sorties approved by the LCC.[21] Appendix B provides a visualization of both request flows.

Once the requested CAS sorties, whether preplanned or immediate, arrive on the battlefield, USAF doctrine requires some form of final, or terminal, control of those assets.[22] Each CAS sortie normally receives a positive clearance from a final controller before releasing any ordnance.[23] The one exception occurs during combat operations when conditions such as low level flight or communications jamming preclude radio contact with the CAS sortie. In this case, the supported ground commander may have to accept the risk of possible fratricide because of poor or nonexistent contact. The aircraft will then release weapons under the concept of "reasonable assurance" meaning the crew is reasonably assured they will hit the correct target. This procedure is an emergency procedure only.[24]

The Air Force has two major categories of final CAS control, positive control and emergency CAS. The presence of a qualified USAF terminal attack controller defines positive control.[25] This attack controller

must be "on the scene, in contact with and in control"[26] of the attacking aircraft. The controller's duties include protecting friendly troops from fratricide and helping to direct aircraft to the target.[27]

Positive control is further broken down into two subcategories, direct and indirect control. The terminal controller achieves direct control when he can observe the target area and attacking aircraft, identify friendly positions to ensure their safety, and exercise clearance and abort authority over the attacking aircraft.[28] Indirect control differs from direct control in that the terminal controller cannot see either the target or attacking aircraft during ordnance delivery.[29] The USAF further subdivides indirect control into two more specific categories, indirect control through an observer and indirect control with no observer. In the first case, the terminal controller maintains contact with someone who sees the target or target area and can issue the clearance or abort the attackers if necessary. With no observer, the final controller must coordinate control measures with the supported ground commander and attacking aircraft before weapons delivery. The ground commander must approve the indirect control mode with no observer.[30]

Emergency CAS is the last major category of final

control. As implied by the name, emergency CAS, as a form of final control, takes place only in emergency, wartime situations when no qualified USAF terminal controller provides final control for the attacking aircraft. In this instance, the ground commander may designate someone else to control the airstrike.[31] Risks to friendly troops increase but the situation may require such measures.

Theater CAS Doctrine

As a result of historical experiences with airpower since World War II, the services have worked to reach some agreement on the proper control method for air assets in theater of war. Our current system, demonstrated with some success in Desert Storm, allows the Joint Force Commander (JFC), or Theater Commander, to establish a single individual in charge of all air operations, the Joint Force Air Component Commander (JFACC).[32] The JFACC helps the JFC determine the proper apportionment (i.e. assignment of total air effort by percentage or geographic areas) and then, through his theater command and control structure, executes the JFC's apportionment decision.[33]

A brief review of the JFACC organization and its relationship to the theater ground forces within a joint force begins the focus of applying CAS on the tactical battlefield. Appendix B shows the organizational structure for the Theater Air Control

System/Army Air Ground System (TACS/AAGS), the USAF/USA doctrinal command and control system for theater air assets.[34] This system strongly supports the USAF doctrine of centralized control and decentralized execution and yet, still provides the JFC with a responsive force with the utmost in tactical flexibility.[35] The following paragraphs highlight the major planning and execution organizations within the TACS/AAGS which directly impact on the application of CAS.

The senior USAF organization within TACS/AAGS is the Air Operations Center (AOC) which provides centralized control for the theater air assets. The AOC, a theater level echelon, monitors current air operations and plans future operations. It also calculates, based on the JFC apportionment decision, total sortie numbers by mission type (allocation). Furthermore, the AOC provides decentralized execution of on-call CAS sorties to the Air Support Operations Center (ASOC).[36] The Army commander, or LCC as appropriate, makes the distribution of CAS assets down to the Corps level.[37]

The senior USAF liaison element to Army forces is the ASOC. Normally located at a corps headquarters, it may also collocate directly with echelons above or below a corps, as required.[38] Key responsibilities of the ASOC include assisting Army planners, employing the

distributed CAS sorties, and operating the Air Force Request Net (AFARN), the communication net used for immediate CAS requests.[39]

USAF expertise is provided at maneuver headquarters below the corps level by the Tactical Air Control Party, or TACP. Manning for each TACP is based upon the assigned echelon but, as a minimum, all have Air Liaison Officers (ALO) and Tactical Air Command and Control Specialists (TACCS).[40] The ALO serves as the air advisor to the ground commander and provides terminal attack control for air assets. TACCS operate and monitor the AFARN.[41]

The Army has a similar system, AAGS, which operates in parallel with the TACS. Each USAF organization within the TACS has a corresponding Army counterpart responsible for the planning and approval of air support requests. For example, the Battlefield Coordination Element (BCE), normally a theater level organization, is collocated with the AOC and provides land force requirements for air support to the AOC.[42] Each echelon below theater, down to battalion, has a Fire Support Element (FSE), responsible for all fire support planning including air, which works closely with the USAF TACP.[43]

In summary, the TACS/AAGS provides the JFC with the means to plan and execute missions with assigned air assets. In fact, all preplanned air support

requests are submitted through the Army side of TACS/AAGS with final approval given by the LCC.[44] Close coordination between the USAF and USA, through parallel organizations such as the AOC and BCE, ensures the ground forces get the USAF air support they need, when and where required.

Historical Background

Before developing a bomber CAS concept of operations, some appreciation for the history leading to our present CAS system, comprised of both command and control procedures and doctrine, is necessary. The British World War II experience in North Africa, in particular, reflects the present theater CAS system in both function and organization. During this period, the British went from an air support system which did not work to one very comparable to the TACS/AAGS used today by the US Air Force and Army. A diagram of the current system is shown in Appendix B and serves as good reference during the discussion of the British system.

The British air operations in North Africa had instances both of great failure and success. Particularly vexing was the limited impact of air support during two British efforts to relieve Tobruk in May and June 1941 where air support was inadequate and did not contribute appreciably to the operations.[45] Both the air and ground headquarters were widely

separated during the operations, precluding close coordination, with neither having the necessary communications for requesting or controlling the aircraft.[46] Because of the breakdowns, the Royal Air Force (RAF) and Army established a working group to resolve these and other problems. The result of this working group was the Direct Air Support System (DASS) which went into effect September 1941.[47]

Three different types of organizations comprised the DASS, the RAF Western Desert Headquarters (HQ), the Air Support Control (ASC) HQ, and the Forward Air Support Links (FASL).[48] A FASL existed at the brigade and division levels, serving as communication channels for strike aircraft and as a conduit for all air support requests. These FASLs communicated directly with the ASC, collocated with the Army HQ, and passed targeting data and air requests upward. The ASC, after considering and approving air strikes, contacted the RAF HQ and requested the air strike. With RAF HQ approval, the strike was launched. The strike aircraft then contacted the brigade FASL, or division if applicable, where they received updated target information. After mission completion, aircrews recontacted the FASL to provide strike results for passage to the ASC and Corps.[49]

A quick comparison shows there are numerous similarities between the British DASS of 1941 and the

present TACS/AAGS (Appendix B). The function and placement of the DASS components almost exactly mirrors the components of the TACS/AAGS in use today. Two differences do exist, however, which are worth noting. First, the TACS/AAGS AOC, unlike the RAF Western Desert HQ, does not have approval authority for the air requests. Approval is instead given at the Corps level by the LCC and coordinated through the ASOC.[50] But, the AOC does contact the tactical squadrons and orders the air strikes launched through the Air Tasking Order.[51] Lastly, the British FASL was found down to only the brigade level unlike its counterpart in the TACS/AAGS, the TACP, which is found at the battalion level as well.[52]

Evaluation Criteria

This brief review of doctrine and history in the previous paragraphs suggests several common factors useful in judging any concept of operations involving the CAS mission. These factors are flexibility, responsiveness, accuracy, and control.

The ability to quickly respond to dynamic conditions on the battlefield defines flexibility. The TACS/AAGS, described above, demonstrates one example of flexibility. By using the immediate air request, a ground commander obtains additional support by having preplanned sorties diverted. This provides commanders with more options on how to deal with the battlefield.

Responsiveness, in CAS missions, is the ability to respond in a timely fashion to the battlefield. Richard Hallion notes in his book Strike from the Sky that during Operation Crusader, November 1941, a British operation in North Africa, the average time between request and air attack was two and one half to three hours.[53] The ground forces in contact felt this was an excessive amount to time. On the other hand, present CAS doctrine suggests 15 minutes as the a minimum time for an immediate request aircraft to strike the target, although it may be longer.[54] Obviously,the shorter time between request and strike, the better support provided to ground forces.

Accuracy is simply the capability of putting ordnance on the desired target. Two reasons make this important. First, aircraft attack most targets to destroy them. A miss does not accomplish the destruction. Secondly, accurate strikes reduce the possibility of fratricide. The services, concerned about fratricide, developed risk estimate tables in TACP 50-28, J-Fire Multi-Service Procedures for Joint Application of Fire Power. These tables show, based on weapon type delivered by an aircraft, the minimum weapon impact distance away from troops which results in a ten percent friendly casualties.[55] With this data, the ground commander can make informed decisions on how close to allow weapon impacts based on his ALO's

knowledge of the accuracy of the CAS weapons. The need for accurate delivery of weapons places a strict requirement on the type and precision of the target data obtained.

Control ensures that aircraft strike the correct target where and when it is necessary. Poor communications, technological inadequacies, and improper procedures affect control which stand as the most important evaluation criteria. It provides, through various means, a method of reducing fratricide. One historical example highlights the danger of poor or nonexistent control. During Operation Cobra, in conjunction with the July 1944 Normandy breakout, medium and heavy bombers supported ground forces. Because of problems with communications and abort procedures, the bombers' inaccurate bombing resulted in the deaths of over 100 American soldiers and the wounding of approximately 500 more over a two day period.[56] One of the casualties was Lieutenant General Leslie J. McNair, the former commander of Army Ground Forces.[57] Today, strong control, to reduce or overcome this problem, may include fire support coordination measures, redundant and dedicated communication systems as well as standardized procedures to provide a common understanding among the various agencies involved with CAS.

III. Building Blocks

Having built a foundation for the bomber CAS concept of operations using doctrine and history, the monograph next discusses the materials, or building blocks, with which to build it. Two key areas, planned bomber modernization and weapons, serve as the basic building blocks for development of the bomber CAS concept.

Planned Bomber Modernization

For bombers to play a significant role in the CAS mission, they need the capability to deliver the appropriate ordnance at the right time and place. The three current USAF bombers (i.e. the B-52, B-1B, and B-2A) are now in the process of being modified to better support a conventional war and the close air support mission. This type of war, much different in aircraft and weapon requirements from a nuclear war, will more than likely require CAS capable aircraft and weapons. As the aircraft missions change from nuclear to conventional, so must aircraft equipment change to support these new missions. The USAF has outlined its plan to modify the bomber fleet in the "Bomber Roadmap" released in June 1992. This roadmap lays out, in great detail, the changes which are planned for each of the three types of bombers.

Common modifications to both the B-52 and the B-1

will be the addition of a Global Positioning System (GPS) receiver, and its integration into the navigational and bombing computers, a Military Standard 1760 (MIL STD-1760) electrical aircraft-to-weapon interface, and a secure radio system.[58] The GPS, whose value was proven in DESERT STORM, will provide bombers with improved navigational accuracy. This in turn will greatly enhance the accuracy of any precision (smart) standoff weapons carried by either the B-52 or B-1 as well as improving the delivery accuracy of "dumb" bombs. The MIL STD-1760 interface will allow the aircraft to "talk" to the new smart weapons, one computer to another. Critical targeting data, as well as launch conditions such as aircraft/weapon present position, target coordinates, altitude, airspeed, heading, and outside air temperature, pass from the aircraft to the weapon so that the weapon's navigational system starts from a precise location. Finally, the B-52 will also be modified with a Heavy Stores Adapter Beam (HSAB) on the external wing pylons allowing carriage and launch of some of the new standoff weapons being developed.[59]

The B-2, the newest bomber in the inventory, is being built with the MIL STD-1760 interface as part of its basic equipment. The only additional equipment to be added will be the GPS.[60] As a result, the B-2 will be fully capable of supporting precision standoff

weapons when it becomes operational.

Weapons

The second half of the bomber/weapon combination is, obviously, the weapons. Much press has been devoted to the new wonder weapons, particularly the Laser Guided Bombs (LGB), during and after the recent war in Iraq. Their impact on the battlefield, when properly employed, is large and their cost in terms of lives, dollars, and available assets relatively small. One historical example of their effectiveness occurred during the attack on the Paul Doumer Bridge in North Vietnam. Hundreds of sorties with thousands of bombs had attacked this bridge since 1964. Using LGBs over a two day period in May 1972, USAF and USN aircraft destroyed this bridge, along with five others.[61]

Although LGBs made a significant impact during both the Vietnam and Gulf Wars, they do have one significant disadvantage, especially in a high threat air defense environment. LGBs, as utilized today, require that some form of laser energy be placed on the target during the terminal phase of the weapon's flight. Detected by the seeker head, the laser light reflected from the target provides information used to develop control inputs for the autopilot. The autopilot then applies the inputs to the flight control system and flies the weapon to the target.[62] At present, the two most available forms of laser

designation are the systems mounted on aircraft and those carried by ground forces.[63] Both laser systems require the operators to be within laser range of the target until weapon impact. In a high threat environment this can be very dangerous. In addition, should the laser be shut off prior to impact, all that remains is a "dumb" bomb no longer under control of the onboard autopilot but, instead, reacting only to the laws of physics.[64] To overcome this, the armed forces are developing a number of weapons which not only offer precision but a high degree of inflight autonomy (i.e., not requiring data links, trailing wires, etc.) as well. This paper discusses the three most promising weapons.

The first of these new autonomous weapons is the Joint Direct Attack Munition (JDAM) currently being co-developed in a three phase program by the US Air Force and Navy. Each program phase results in improved capabilities to the basic weapon system which is a general purpose gravity bomb. Phase I will produce a guidance kit, attached to the standard MK-84 or BLU-109/B 2000 pound class bombs, which incorporates both an inertial navigation system (INS) and a GPS. A new 500 pound bomb and associated fuzes will be developed in Phase II and the final phase, Phase III, will yield a terminal seeker for a family of general purpose bombs.[65] Recent tests of a prototyped

technology of the Phase I guidance unit showed amazing results. In a series of five successful test launches, at release ranges from six to fourteen miles from the target, the JDAM's greatest miss distance was eleven meters.[66]

One of the major benefits of the JDAM is that once released there is no longer any required operator input to the weapon, such as laser designation. The weapon's onboard computer and INS uses the target coordinates, provided by the aircraft, to fly the weapon to the target. GPS inputs to the INS ensure that the most accurate data are used to guide the weapon to impact. No longer will adverse weather hamper the precise delivery of munitions and problems associated with the aircraft onboard bombing computers are lessened by the weapon's precision guidance capability.[67]

Although not requiring a laser designator for terminal guidance, the JDAM provides little or no standoff capability for the aircraft as it is essentially an unpowered gravity bomb. The standoff range is, therefore, highly dependent upon both launch altitude and airspeed.[68] Its precision may reduce the number of missions which must be flown against any particular target; but, it does not by itself significantly enhance the aircraft survivability in a threat environment. A precision weapon with true standoff capability, for purposes of this paper, in

excess of 50 nautical miles (approximately 90 kilometers) solves this problem. This range value would keep the launch platform out of range of the potentially overwhelming number of short range air defense systems and provide maneuver space against medium and long range air defense systems.[69] The JDAM also is designed with a one piece, or unitary, warhead making it more appropriate for point targets.[70] This design feature makes the system somewhat difficult to use against large armor formations or moving targets which is the crucial requirement in a two MRC scenario.

The Air Force, realizing the inadequacies of the JDAM, is developing a number of new weapons, one of which is the Joint Standoff Weapon (JSOW). This system has a respectable standoff performance and the ability to carry submunitions more suitable for attacking armored formations, moving or stationary, than a unitary warhead.

Initially developed by the US Navy as the Advanced Interdiction Weapon System (AIWS), the JSOW is a glide bomb capable of carrying antiarmor submunitions and delivering them within 15 meters of the desired aimpoint.[71] The USAF plans, at this time, to develop carriage capability to handle this weapon on all three types of bombers.[72] Designed jointly for the USAF and USN, this weapon has an unpowered range of 40 nautical miles.[73] However, its GPS updated inertial navigation

system combined with the ability to operate autonomously more than make up for its shorter than desired range. Furthermore, the USAF is developing a powered version, as a pre-planned product improvement (P3I), to increase the JSOW's range. Additionally, new seekers, in development, will allow the missile to do self targeting using target recognitions algorithms designed into the seeker head controllers, whether it be a television or infrared seeker.[74] These seekers, as well as the INS/GPS guidance system, share a common development program and technology with those being used for the JDAM.[75]

The main strength of this weapon, in addition to its precision standoff capability, is its ability to carry and dispense the BLU-108/B, Sensor Fused Weapon (SFW). The SFW, a submunition designed to locate, attack, and kill armored vehicles, will play a key role in defeating armored forces in any future conflict. The SFW will be discussed in more detail in a following paragraph.

Third-party targeting provides the JSOW with another important capability. This form of targeting occurs whenever the targeting information, unknown prior to aircraft launch and later acquired, is passed, via a third-party such as an AWACS or ABCCC, to the carrier aircraft and inserted into the missile computer by the aircrew. The third-party targeting capability,

combined with the addition of a propulsion system, will make the JSOW an outstanding precision standoff weapon.[76]

The ultimate in a precision standoff capable platform is the Tri-Service Standoff Attack Missile, or TSSAM, which is now under development by the USAF, USA, and USN. Designed for carriage on the B-52, B-1, and B-2 and for use in the US Army's Multiple Launch Rocket System with the Army Tactical Missile System (ATACMS), this missile, recently declassified, has a range, when air launched, in excess of 100 nautical miles (185 kilometers).[77] TSSAM provides a capability to carry various "smart" submunitions such as the Brilliant Antitank Weapon (BAT) as well as a unitary warhead. The exact number of submunitions carried and information on its guidance system do not yet appear in unclassified literature. Capable of autonomous operation (i.e., no data link required), the TSSAM makes use of low observable technologies to improve its penetration and survivability characteristics.[78]

The JSOW and TSSAM, mentioned above, serve as extended delivery platforms for a variety of warheads and submunitions. The missiles cannot kill targets on their own. Their killing capability derives directly from types of submunitions they carry. Two specific submunitions, mentioned by Secretary of Defense, Les Aspin, during a 16 June 1993 at the National Defense

University Graduation, are the Sensor Fused Weapon (SFW) and the Brilliant Antitank Weapon (BAT). The JSOW will carry the SFW and the TSSAM the BAT. These "smart" submunitions, once released from either the JSOW or TSSAM, are specifically designed to autonomously detect and attack armored vehicles. They will, therefore, play a key role in stopping enemy armored attacks in the first days of a MRC.[79] A brief description of each submunition follows.

The SFW, also known as the BLU-108/B, is a parachute retarded submunition carrying four smaller projectiles, or sub-submunitions, called skeets.[80] The submunition contains an infrared seeker and a dual nozzle rocket motor. Once ejected from a missile, the SFW submunition deploys its parachute and orients towards the ground. This enables the seeker head to begin searching for targets. Upon target detection, the onboard rocket fires and the four skeets "attack" the target from above. Current planning has the JSOW carrying six SFW submunitions with a total of 24 skeets.[81] As a side note, there exists the possibility of BAT carriage in the JSOW because of the size similarities between the two submunitions, although there appears to be no ongoing development work at this time.[82] Also, no information on TSSAM carriage of the SFW was found in the open press. However, a comparison between the JSOW and TSSAM, based on weight, suggests

that the TSSAM, which is more than twice as heavy, will be capable of carrying at least six SFW, if not more.[83] Additionally, TSSAM is already designed to carry the BAT which, as mentioned above, is roughly comparable in size to the SFW.[84]

BAT, the latest of the new submunitions, will provide the US armed forces with an air deliverable antitank/antiarmor capability. Designed to be carried in the US Army's ATACMS as well as the TSSAM, the BAT is an autonomously guided hit-to-kill submunition.[85] Once ejected from the carrier missile, the BAT free falls and uses its on board sensor systems to guide towards and attack targets. The first sensor system tracks armored vehicles based upon their acoustic signature while the second, an infrared sensor, guides the BAT towards the vulnerable areas of the armored vehicles.[86] The total number of BAT munitions carried in the TSSAM has not yet been made public although its weight of 44 pounds, length of 36 inches, and 5.5 inch diameter makes it comparable to the SFW. This suggests the potential for a similar carriage capability.[87]

The Air Force, with its work on the new missiles and "smart" submunitions, has implicitly acknowledged that precision standoff weapons are crucial to success in an MRC. Furthermore, to ensure compliance with Secretary of Defense Aspin's stated mission of stopping an initial armor attack, the actual destructive

mechanisms carried by the missiles must not only be more intelligent but more accurate as well.[88] No longer will a near miss be good enough. Under the constraints of a decreasing defense budget and a two MRC commitment, the weapons must destroy the target on the first attack. JSOW and TSSAM, integrated with the SFW, and BAT, will provide a first attack kill capability for the Air Force.

IV. Concept of Operations for Bomber CAS

The tactical concept, described and analyzed below, answers the question of whether or not there is a place in the CAS mission for USAF bombers by developing the concept and interweaving an on-going analysis using the previously determined criteria of flexibility, responsiveness, accuracy, and control.

Scenario

The scenario for the concept of operations, assumes full US engagement in one MRC with North Korea (NK), facing an aggressive, armor heavy North Korean Army. As a result, Saddam Hussein, still the Iraqi leader, now feels he has the opportunity to force re-unification with Kuwait on his terms. He once again invades Kuwait and begins a push into Saudi Arabia. Initially, his gains are large, but he does make an operational pause to move logistic assets forward and

reconstitute his forces. The United States, reacting to this threat, must initially rely on the reconstituted 82d Airborne Division, in a forcible entry mission, to gain a lodgement for reinforcements and to stabilize the situation in Southwest Asia (SWA), which has become the second MRC. The 18th Airborne Corps Commander, designated as the Joint Force Commander (JFC), has arrived in theater and has established his headquarters. He simultaneously directed the JFACC, the senior ranking Air Force officer in theater, to establish and implement the TACS/AAGS, providing the JFC with control of his air assets. The JFACC subsequently received one command and control aircraft squadron equipped with Airborne Warning and Control System (AWACS) and Airborne Battlefield Command and Control Center (ABCCC) aircraft. At the same time, the JFC ordered the JFACC to begin counterair operations resulting in local air superiority during the forcible entry and follow-on reinforcement missions. He also deployed his available ground forces into hasty defenses, awaiting reinforcements from the United States as well as the newly formed coalition members. The bomber CAS concept of operations described below will make use of the TACS/AAGS (Appendix B) and the immediate CAS request flow (Appendix C) procedures unless otherwise noted.

Bomber CAS in support of ground forces committed

to a second MRC provides the common thread for this concept. Organized as a doctrinal USAF/USA theater, this MRC contains a Joint Force Commander (JFC), a Joint Force Air Component Commander (JFACC), and a Land Component Commander (LCC).[89] In addition, the MRC forces will contain one US Army Corps with the Corps commander dual-hatted as the LCC and a USAF numbered air force, a Corps equivalent, providing the JFACC as well as the predominance of theater air power.

<u>Concept</u>

A forward company's observation post detects a large armored formation forward of the main defensive lines and obtains a range and bearing to the formation with a laser rangefinder. Since these armored forces are considered the main threat against US forces, the LCC designated their destruction as the top Corps' priority. The scouts immediately report this find to their commander. After evaluating the threat and determining it must be attacked, the company commander, through his fire support net, passes a request for immediate CAS to the ALO located in the battalion TACP. The ALO, using the scouts' GPS present position and the range and bearing to the target, converts the raw position data into specific target data. He does this using a coordinate conversion program, uploaded on his handheld calculator, which adjusts the present position by applying the range and bearing data to it. Now the

ALO has actual target coordinates.[90] The ALO then passes these coordinates, along with a target description and orientation, directly to the ASOC, via the AFARN, as part of the immediate air request.

As this request passes up through the echelons, each echelon monitors and evaluates the request and signals approval by silence on the net if unable to attack the target with their own assets. The LCC, contacted by the ASOC, makes the final approval and provides this to the ASOC for processing.[91] The ASOC, in close coordination with the BCE, determines the number of aircraft required and the desired weapons load. The ASOC/BCE checks the aircraft/weapon requirement against any on-call or preplanned CAS sorties in the ATO. The ASOC, through its associated TACP, notifies the Corps of the aircraft availability for the mission and then contacts the appropriate WOC to get the aircraft launched, if necessary, and headed towards the target. If sorties must be diverted from other missions, the ASOC first contacts the Corps and, only with Corps approval, diverts the aircraft.[92]

Up to this point, the bomber CAS concept of operations does not differ significantly from steps one through seven of the immediate request flow shown in Appendix C. However, inherent bomber characteristics, such as flexibility and accuracy, impact greatly on the concept of operations and suggest the need for two

changes in the standard CAS flow, bomber location and Air Tasking Order (ATO) incorporation.

A major contributor to flexibility is the range and speed of the bomber which allows bombers to orbit for extended periods of time. A common B-52H range planning factor is an unrefueled combat radius (i.e. from takeoff base to weapons release and return) of 2340 to 3210 nautical miles, dependent upon the amount of low level flight.[93] Since an orbit is merely range flown in a circle, this long range capability easily converts into long loiter times. Longer loiter times mean the aircraft are available for longer periods and can be quickly shifted when and where needed. Speed also improves the flexibility of the bomber. A standard planning factor for the B-52 is an airspeed of 340 knots[94] while the B-1 is capable of airspeeds in excess of 560 knots.[95]

A second bomber characteristic contributing to flexibility is the self-contained navigational capability (Inertial Navigation System or INS) of the bombers. The integration of GPS into the INS will further increase the navigational accuracy allowing bombers to move throughout the battlefield with a high degree of confidence in their location. The idea of improved accuracy combined with flexibility produced by a bomber's range and speed capabilities leads directly to the first change in the immediate CAS request flow.

The first, and major, change to the standard CAS flow is the location of the bombers at notification of a CAS mission. Fighter aircraft, with their shorter unrefueled range and loiter time, are frequently kept on ground alert to ensure availability when needed.[96] The concept has bomber aircraft flying in orbits (designated as rear orbits) approximately 100 nautical miles (185 kilometers) behind the Forward Line of Own Troops (FLOT) with full loads of precision standoff weapons rather than sitting on the ground at a distant air base. Step nine, Appendix C, approximates a bomber's rear orbit location. They will maintain contact with the TACS/AAGS by use of the AWACS, or ABCCC, as available.[97] Upon receipt of the mission data, to include specific target coordinates and orientation, the aircrew will enter the data into the missile in preparation for launch. At the same time, the crew will depart their rear orbit and head towards the front lines and the located enemy target. The bombers, the total number being mission dependent, will fly to standoff attack orbits 50 nautical miles (90 kilometers) from the FLOT. Establishing themselves in their attack positions, they will contact their final controller, who has already been notified of their mission by the ASOC, and verify all targeting data. Once under final control, the aircrews will launch their precision missiles which, in most standoff

situations, will be either the powered JSOW or the TSSAM. The missiles will then fly to the target area and dispense the "smart" submunitions which will search out and destroy any located armored vehicles.

At this point, accuracy of the weapon system, aircraft and missiles, greatly contributes to the strength of the concept of operations. Combining the GPS and INS, in both the aircraft and missiles, has produced, in recent precision standoff weapon flight tests, accuracies down to 11 meters.[98] Also, "smart submunitions," such as SFW and BAT, will enhance the weapon system's overall accuracy because the onboard sensor systems provide terminal guidance to the submunitions after release from the standoff missile.

Bomber orbits, established by the AOC and controlled by the ASOC, have additional relevance because of the increase in aircraft responsiveness to the ground commander's needs. Aircraft located 100 nautical miles behind the lines can reach firing positions in slightly less than six minutes (B-1 at 560 knots); the concept is, thus, extremely responsive to changing situations. Furthermore, this speed, combined with the long range and loiter time mentioned above, increases the bomber flexibility, as well as responsiveness, by providing the capability to move rapidly from one part of the battlefield to another.

If any missiles remain on board after the attack,

the bombers will return to the standoff attack orbits and await further instructions. If no missions are expected in the immediate future, the bombers will be ordered to fly to rear orbit areas and resume their patrol.

The number of orbits established by the Air Operations Center (AOC) obviously depends upon the number of bombers in theater. If the AOC required 80 bombers[99] with an assumed mission capable rate 80 percent,[100] it would establish four to six orbits with three aircraft apiece within 100 to 200 nautical miles (185 to 370 kilometers) of each other and oriented parallel to the FLOT. The assigned aircraft would orbit for eight hours or until all ordnance is expended. If the aircraft did not expend their ordnance within eight hours, they would return to their forward operating locations for refueling, reloading, and maintenance. Another group of three bombers would launch at some pre-determined time to assume responsibility for the vacated orbits. This cycling of bombers allows for 24 hour coverage of the orbits. Should the ground situation be extremely uncertain, the bombers could be supported by air refueling behind the rear orbits. This would allow even longer on-station times should the threat situation so dictate.

The second required change is the inclusion of orbit area planning, by both ground and air force

personnel, within the ATO cycle. Both orbits, rear and standoff attack, need to be incorporated into the ATO. This allows for joint supression of enemy air defense planning as well orbit area deconfliction. Planners will also schedule additional support aircraft, for either air refueling or command and control, and the proposed flight paths of the aircraft as they transit to attack orbits and the precision missiles as they fly to the target area into the ATO. Close coordination is required with the ground forces' air defense and the Army Airspace Command and Control System to preclude accidental shoot downs of these missiles or aircraft as they transit the Corps' rear area.

Control, the final evaluation criteria, ensures the aircraft attack the correct target at the right time and place. Control in this concept, however, is highly dependent upon functioning communication systems and effective final observers and herein lies the greatest current challenge to successful implementation.

The chain of communications for this concept reaches from the forward observer at the front lines back to the bombers in their rear orbits, a distance of approximately 100 nautical miles (185 kilometers). Any disruption of communications may preclude precise strike coordinates from reaching the bombers and may easily negate their effectiveness in a CAS mission.

Combine communication problems with the fact the aircraft and missiles must transit friendly airspace, possibly overflying friendly troops and air defense systems, and the dimensions of this problem become obvious. One positive aspect must be highlighted. If the communication systems are fully functional, the CAS concept will be extremely responsive to the ground commander with the potential of having missiles on target in as little as 15 minutes.

The final problem with control as applied to the concept of operations is the idea of "eyes-on" the target, or final control. As suggested in MCM 3-1, Vol VIII, the preferred method of final control is called positive control wherein a qualified USAF observer has visual contact with both the target and aircraft attacking the target.[101] With missiles being launched 50 nautical miles or more behind the FLOT, positive control will not be achievable.

Overall, this concept of operations meets three of the four evaluation criteria in a satisfactory manner. The bomber's inherent capabilities and the orbit locations allowing rapid aircraft re-positioning on the battlefield both support flexibility. Aircraft speed and range allow the bombers to be responsive to a ground commander's needs while the planned accuracies of the aircraft and missiles ensure target destruction. Only the area of control presents the greatest

potential for disruption of the concept. Unreliable or poor communications can affect the accuracy of the missiles because of target data and the responsiveness as well.

V. Conclusions

> Even in the 1990s... the B-52 *is* [author's emphasis] air power in a way no other air system matches, at once ironic and fitting for a system whose first conceptual requirement dated to 1944. The threat of sending the B-52 to war signals the seriousness with which American leadership views a crisis.[102]

This monograph answers the question of how bombers could perform the CAS mission in a future conflict by developing and evaluating a bomber CAS concept of operations. Factors such as a decreasing defense budget and a new national military strategy drive the services to be much more creative with the assets available.

The concept of operations was created in a fashion similar to that of raising a building. First, a foundation, based upon CAS doctrine and history, was developed which in turn led to four criteria on which to evaluate the concept. These criteria--flexibility, responsiveness, accuracy, and control--were then used as standards by which to judge the concept. Lastly, the building blocks, in this case planned bomber modernization and weapons, were gathered and the bomber CAS concept of operations developed from them.

A modernized bomber fleet with upgraded electrical interfaces and GPS will allow the use of new precision standoff weapons such as the JSOW and TSSAM. These weapons, in turn, with their demonstrated accuracy and lethal armor killing submunitions will give the bombers a long range tank killing capability strong enough to, as a minimum, delay or disrupt the initial armored attacks in a second MRC. The bomber, with its inherent characteristics such as speed and long range, and armed with the new precision standoff weapons will give the ground commander a highly accurate, flexible, and responsive weapon system to call on when needed.

This is not to say that the concept does not have any weaknesses. In fact, control of the aircraft is highly dependent upon an effective and functional communication system, for example the USAF/USA TACS/AAGS. Should this communications system not function properly, both targeting data transfer, and thereby accuracy, as well as bomber responsiveness will suffer. Furthermore, factors such as logistic support, suppression of enemy air defenses, and air refueling were not discussed in detail because of a lack of space and do warrant further study as to their implications for this concept.

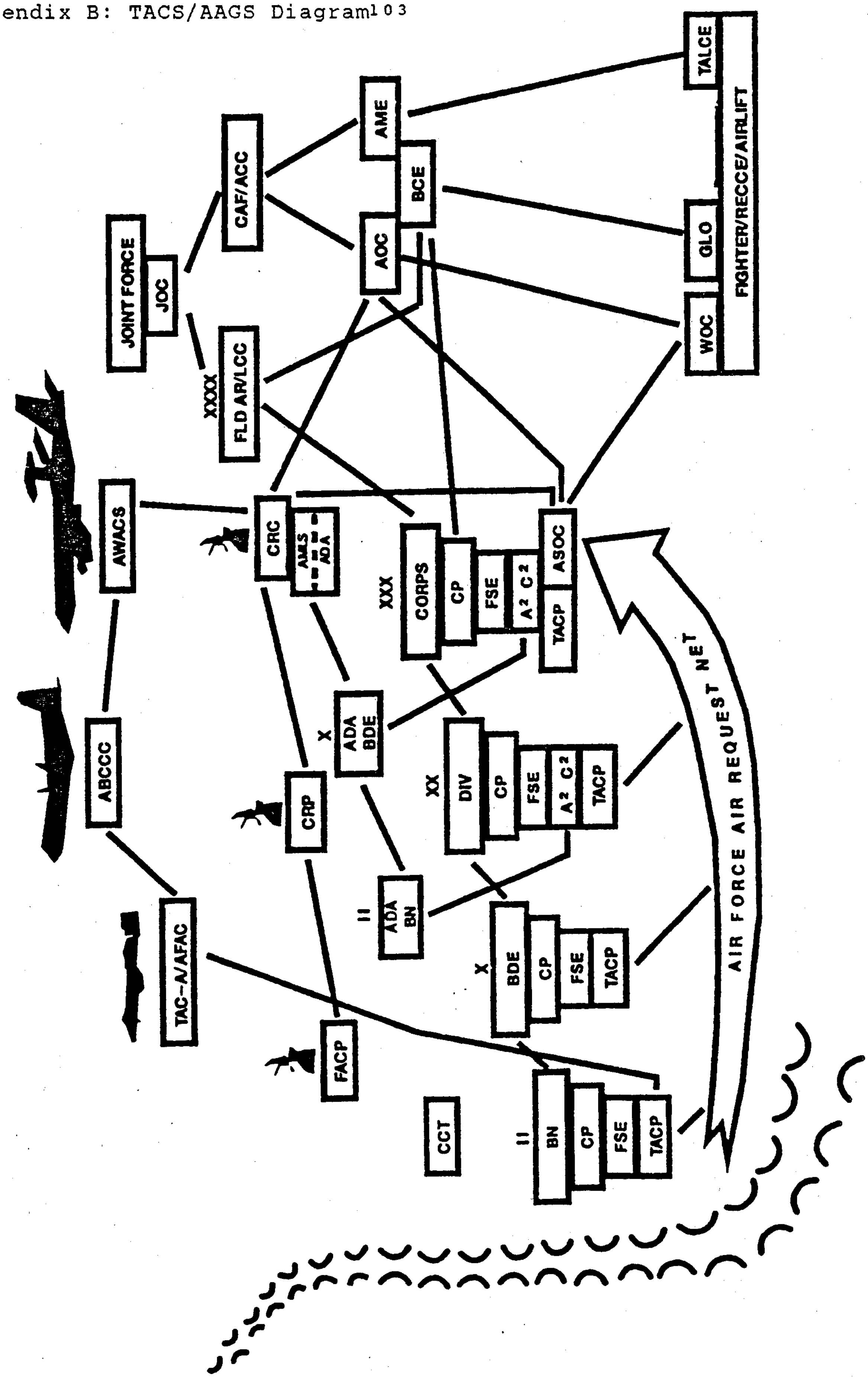
The heavy bomber performing the CAS mission is an idea whose time has come again. This monograph has provided a concept of operations which should serve as

a starting point for further, more detailed studies. The USAF should evaluate this concept so as to improve its close air support capability in these times of decreasing defense budgets and increasing regional conflict.

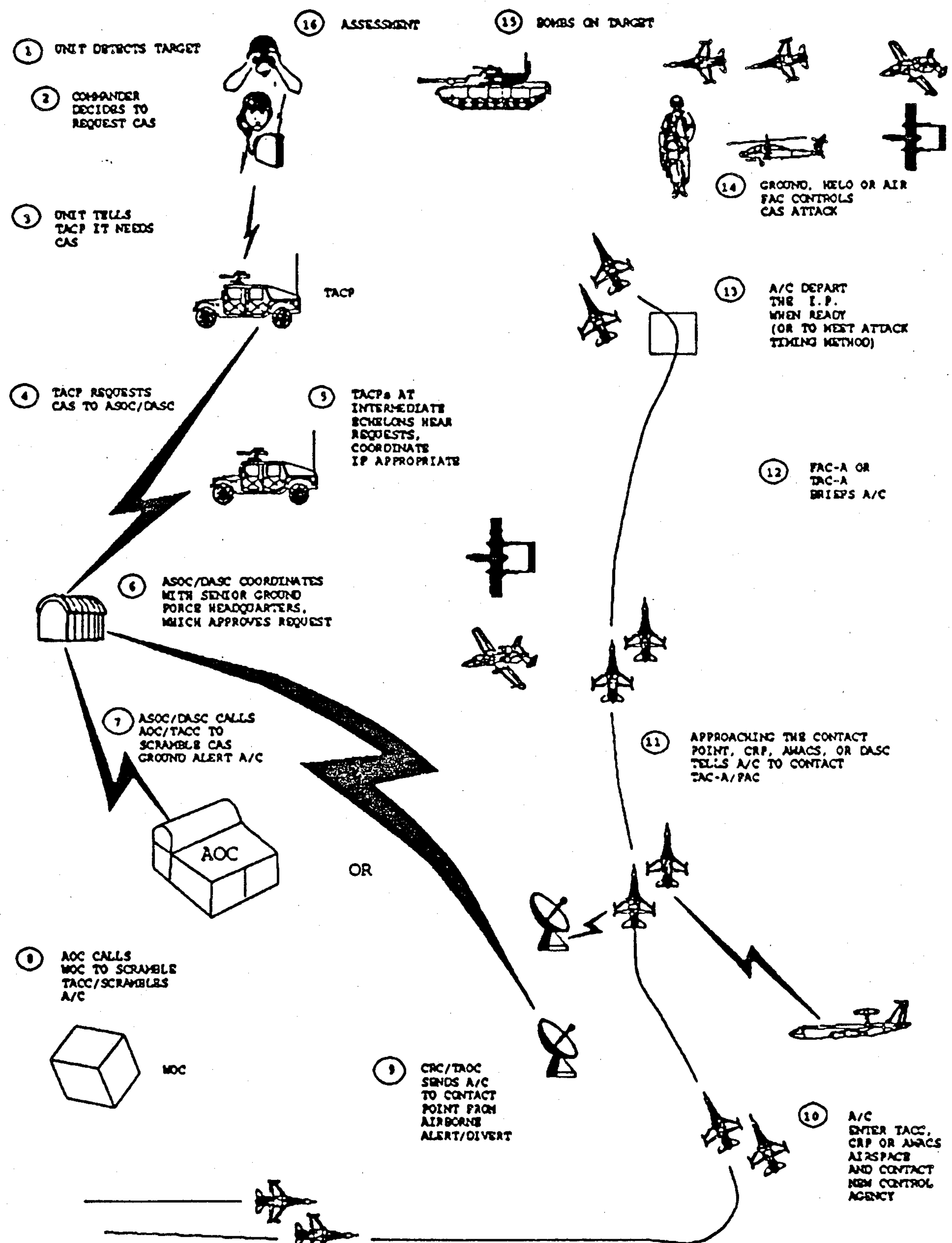
Appendix A: Key Acronyms

ABCCC	Airborne Battlefield Command and Control Center
ACC	Air Component Commander
AFARN	Air Force Air Request Net
AFAC	Airborne Forward Air Controller
ALO	Air Liason Officer
AOC	Air Operations Center
ASC	Air Support Control
ASOC	Air Support Operations Center
ATO	Air Tasking Order
A2C2	Army Airspace Command and Control
AWACS	Airborne Warning and Control System
BAT	Brilliant Antitank Weapon
BCE	Battlefield Coordination Element
BLU	Bomb Live Unit
CBU	Cluster Bomb Unit
CCT	Combat Control Team
CRC	Control and Reporting Center
CRP	Control and Reporting Party
DASS	Direct Air Support System
FACP	Forward Air Control Party
FASL	Forward Air Support Links
FEBA	Forward Edge of the Battle Area
FLOT	Forward Line of Own Troops
FSE	Fire Support Element
GLO	Ground Liason Officer
GPS	Global Positioning System
INS	Inertial Navigation System
JDAM	Joint Direct Attack Munition
JFC	Joint Force Commander
JFACC	Joint Force Air Component Commander
JOC	Joint Operations Center
JSOW	Joint Standoff Weapon
LCC	Land Component Commander
SFW	Sensor Fused Weapon
SUU	Suspension Unit
TAC-A	Tactical Air Coordinator-Airborne
TACCS	Tactical Air Command and Control Specialist
TACP	Tactical Air Control Party
TSSAM	Tri-Service Standoff Attack Weapon
WOC	Wing Operations Center

Appendix B: TACS/AAGS Diagram[103]



Appendix C: Typical Immediate CAS Request Flow[104]



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1. US Air Force, AFM 1-1, Basic Aerospace Doctrine of the United States Air Force, Volumes I and II (Washington D.C.: Department of the Air Force, 1992), pg. 13. Hereafter referred to as AFM 1-1.

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3. US Army, FM 100-5 Operations (Washington D.C.: Department of the Army, 1993), pg. 2-19.

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5. Les Aspin, Remarks to the National Defense University (NDU) Graduation at Fort McNair, 16 Jun 1993. News release from the Office of the Assistant Secretary of Defense (Public Affairs), Washington D.C.

6. Christopher Bowie, Fred Fostic, Kevin Lewis, John Lund, David Ochmanek, and Philip Propper. "The New Calculus: Analyzing Airpower's Changing Role in Joint Theater Campaigns" (Santa Monica: RAND Corporation, 1993), pgs. xi-xiii. Referred to as the "RAND Study" in any further references.

7. Ibid., pg. xix.

8. Ibid., pgs. 20-21.

9. RAND study, pg. 14, and William Matthews, "The Price of Peace," The American Legion, August 1992, pg. 50.

10. Les Aspin, Secretary of Defense, "The Bottom-Up Review: Forces For A New Era" (Washington D.C.: Department of Defense, 1993), pg. 17. Henceforth referred to as the "Bottom-Up Review."

11. RAND Study, pg. 21.

12. Aspin, "Bottom-Up Review," pg. 8.

13. AFM 1-1, Vol I, pg. v.

14. Advance Sheet, 3A GSAC, "Theater Air Control System/Army Air Ground System (TACS/AAGS)" (Hurlburt AFB, FL: USAF Air Ground Operations School, 1993), pg. 10. Hereafter referred to as AGOS.

15. Air Land Sea Application (ALSA) Center, Uncoordinated Draft of Joint Pamphlet tentatively titled J-CAS: Tactics, Techniques, and Procedures, draft dated 25 Aug 1993 (Norfolk, VA: ALSA, 1993), pgs. 3-1 to 3-4. Simultaneously being developed as ALSA multi-service TTP and Joint Publication 3-09.3, JTTP for CAS. Hereafter referred to as Draft J-CAS.

16. This observation concerning the ATO is based upon my experience as the Chief, Bombing and Navigation Branch, for a B-52 wing from Jun 1990 to Jun 1992. My responsibilities included all planning for exercises which to a large degree scheduled aircraft by use of the ATO.

17. AGOS, pg. 10.

18. AGOS, pg. 10.

19. AGOS, pg. 10.

20. AGOS, pg. 10 and Draft J-CAS, pg. 3-2.

21. AGOS, pgs. 10, 11 and Draft J-CAS, pg. 3-5.

22. (S) MCM 3-1, Vol VIII, Mission Employment Tactics, Tactical Employment Forward Air Controller (FAC) (U) (Langley AFB, VA: Air Combat Command, 1992), pg. 4-8. Hereafter known as MCM 3-1, Vol VIII. All information used from this source is unclassified.

23. Draft J-CAS, pg. 5-6.

24. MCM 3-1, Vol VIII, pg. 4-13 and Draft J-CAS, pg. 5-7.

25. MCM 3-1, Vol VIII, pg. 4-8.

26. Ibid., pg. 4-8.

27. Ibid., pg. 4-8.

28. Ibid., pg. 4-8.

29. Ibid., pg. 4-8.

30. Ibid., pg. 4-8.

31. Ibid., pgs 4-8, 4-9.

32. Joint Pub 3-0, Doctrine for Joint Operations (Washington D.C.: Joint Chiefs of Staff, 1993), pg. II-18.

33. AGOS., pg 5.

34. Ibid., pg. 24.

35. _AFM 1-1_, pg. 8.

36. AGOS, pg. 6.

37. Ibid., pg. 8.

38. Ibid., pg. 16.

39. Ibid., pgs. 11 and 16.

40. Ibid., pg. 16.

41. Ibid., pgs. 16-17.

42. AGOS, pg. 15, and US Army, _FM 100-15, Corps Operations_ (Washington D.C.: Department of the Army, 1989), pg. F-1.

43. AGOS, pg. 9.

44. Ibid., pg. 10.

45. Richard P. Hallion, _Strike from the Sky_ (Washington D.C.: Smithsonian Institution Press, 1989), pg. 153.

46. Ibid., pg. 154.

47. Ibid., pg. 154.

48. Ibid., pg. 155.

49. Ibid., pgs. 155-156.

50. AGOS, pg. 10.

51. Ibid., pg. 6.

52. AGOS, pg. 16, and Hallion, _Strike from the Sky_, pg. 154.

53. Hallion, _Strike from the Sky_, pg. 158.

54. AGOS, pg. 11.

55. US Air Force, _TAC Pamphlet 50-28, J-Fire Multi-Service Procedures for the Joint Application of Fire Power_ (Langley AFB, VA: Tactical Air Command, 1989), pgs. 28-9 and 44-5.

56. Hallion, Strike from the Sky, pg. 208.

57. Ibid., pg. 211.

58. See "Enhancing the Nation's Conventional Bomber Force: The Bomber Roadmap," by Donald Rice, Secretary of the Air Force, pgs 8-10. Described for the remainder of the paper as "The Bomber Roadmap." Discussion of the new USAF aircraft radios which are compatible with the US Army's equipment was found in "Two New Jam-Resistant Sincgars Radios Readied for Flight Tests" by Philip Klass in Aviation Week and Space Technology, 4 Jun 1990, pgs 79-81.

59. Rice, "The Bomber Roadmap," pg 8.

60. Ibid., pgs. 6 and 18.

61. Air War-Vietnam (New York: Arno Press, 1978), pg. 253.

62. Richard P. Hallion, Storm over Iraq (Washington D.C.: Smithsonian Institution Press, 1993), pg. 306.

63. MCM 3-1, Vol VIII, pg. 4-19.

64. Hallion, Storm over Iraq, pg. 303.

65. Meeting minutes from the FY 93 Munitions Working Group provided by HQ ACC/DOTW, Weapons and Tactics, pg. 6.

66. "USAF Holds Pre-JDAM Test," Aviation Week and Space Technology, 5 Jul 1993, pg. 27.

67. Meeting minutes from the FY 93 Munitions Working Group provided by HQ ACC/DOTW, Weapons and Tactics, pg. 3.

68. "USAF Holds Pre-JDAM Test," Aviation Week and Space Technology, 5 Jul 1993, pg. 27.

69. US Army, FM 100-2-3, The Soviet Army: Troops, Organization, and Equipment. (Washington D.C.: Department of the Army, 1991), pg. 5-115.

70. Meeting minutes from the FY 93 Munitions Working Group provided by HQ ACC/DOTW, Weapons and Tactics, pg. 3.

71. Clifford Beal and Bill Sweetman, "Bolt from the Blue: stand-off weapon developments" International Defense Review, Aug 1992, pg. 758.

72. Meeting minutes from the FY 93 Munitions Working Group provided by HQ ACC/DOTW, Weapons and Tactics, pg. 16.

73. "Pentagon to Approve JSOW Development, Initial Work on Direct Attack Munition," Aviation Week and Space Technology, 1 Jun 1992, pg. 28.

74. "AIWS/JSOW, Workhorse Weapon for the 1990s and Beyond," pgs 4,5,17. Briefing slides from HQ ACC/DOTW.

75. Meeting minutes from the Fy 93 Munitions Working Group provided by HQ ACC/DOTW, Weapons and Tactics, pg. 12.

76. "Concept of Operations for the Joint Standoff Weapon System," Draft Copy, Provided by HQ ACC/DRAS, Draft received 25 Oct 93, pg. 11.

77. Rice, "The Bomber Road Map," pgs. 8-12 and the SECAF press release entitled "Tri-Service Standoff Attack Missile (TSSAM)" received from HQ ACC/DOTW Oct 1993.

78. SECAF press release entitled, "Tri-Service Standoff Attack Missile (TSSAM)" recived from HQ ACC/DOTW Oct 1993.

79. Les Aspin, Remarks to the NDU Graduation, 16 Jun 1993.

80. David A. Fulghum, "Aspin Eyes New Missions For Sensor Fuzed Weapon," Aviation Week and Space Technology. 26 Jul 1993, pg. 46.

81. "AIWS/JSOW, Workhorse Weapon for the 1990s and Beyond," briefing slides from HQ ACC/DOTW, pg. 4, and Sensor Fused Weapon (SFW) Submunitions Weapons Characteristics Handout from HQ ACC/DOTW.

82. David Hughes, "Raytheon Capitalizes on Microelectronics in BAT Seeker, Other Smart Munitions," Aviation Week and Space Technology, 2 Mar 1992, pg. 50, and Sensor Fused Weapon (SFW) Submunitions Weapons Characteristics Handout from HQ ACC/DOTW.

83. "USAF Almanac 1993," Air Force Association Magazine, May 1993, pg. 147, and "AIWS/JSOW, Workhorse Weapon for the 1990s and Beyond," briefing slides from HQ ACC/DOTW, pg. 4.

84. Hughes, pg. 50, and Sensor Fused Weapon (SFW) Submunitions Weapons Characteristics Handout from HQ ACC/DOTW.

85. Hughes, pg. 50.

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88. Aspin, "Bottom-Up Review," pg. 7.

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90. The computer software for accomplishing this transformation exists in the form of Target Study Officers' (TSO) Tools. TSO Tools was developed by HQ Strategic Air Command SAC personnel and provided to all bombardment wings. It was designed for and used in handheld calculators as well as desktop computers.

91. AGOS, pg. 11.

92. Ibid., pg. 22.

93. Eighth Air Force/DOTT, Warfighter's Guide to Conventional Heavy Bomber Employment (Draft) (Barksdale AFB, LA: Eighth Air Force, 1992), pg. 4.

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95. Ibid., pg. 17.

96. AGOS, pg. 10.

97. Ibid., pg. 22.

98. "USAF Holds Pre-JDAM Test," Aviation Week and Space Technology, 5 Jul 1993, pg. 27.

99. The support for this number comes from the discussion by Richard Hallion in his book Storm over Iraq. He discusses (pg. 218) that 74 B-52Gs were used during Desert Storm, 61 percent of the total available. The "Bottom-Up Review" has recommended a bomber fleet consisting of a total of 184 aircraft so the 80 recommended in this concept will comprise only 44 percent of the total available, a reasonable assumption.

100. The figure of an 80 percent mission capable (MC) rate was developed from table 6.5, pg. 197, of Storm

over Iraq by Richard Hallion. The table lists MC rates for eleven different aircraft ranging from the venerable KC-135 to the new F-117 as experienced during Desert Storm. The average value of 80 percent developed from these rates is further supported by the monograph author's experience at a heavy bomber unit.

101. *MCM 3-1, Vol VIII*, pg. 4-8.

102. Hallion, *Storm over Iraq*, pg. 67.

103. AGOS, pg. 24.

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